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Some Results of Biological Experiments in Rockets and Sputnik II

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SCIENTIFIC research work investigating the effect of space flight upon living organisms has been carried on in the Soviet Union since 1949. Penetration of the upper air layers by animals is achieved with the help of rockets.

The first thing was to place the animals in specially equipped and hermetically-sealed cabins which were supplied with an air-conditioning system allowing to keep up the gas composition of the air, the temperature, and humidity at the required level so as to make the normal vital activity of the organism possible. The air conditioning system created the necessary conditions for the life of two days during three hours under observation. The rocket flew at a height of 100-210 kilometers (62-130 miles). In the course of the flight the hermetically-sealed cabin separated itself from the rocket and regained the earth with the help of a parachute bringing back the animals.

Special instruments and apparatus enabled the scientists to register the animals' breathing, blood pressure, biological electric currents and temperature just before the start, and during the actual space flight and the parachute flight. They could also register all the changes in pressure and temperature of the air in the cabin, and the acceleration.

The analysis of the data collected points to the fact that the conditions existing at the height of 100-200 km. make life possible. There are hardly any considerable changes at all in the living organisms, which could be regarded as the result of acceleration, when the rocket was started or when the parachute reached the dense air layers. The effect of the inevitable absence of gravity to which the animals were subjects for from 3 to 6 minutes was almost imperceptible and

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their condition was quite satisfactory. Some animals travelled twice into space, but as in the previous case they showed no perceptible change in their behavior or general condition, neither immediately after the flight nor at any time later during observations in the laboratory. The results of the investigation showed that, provided all the physiological requirements for flight were observed, the space flight itself held no danger or harm for the life and health of the animal.

The next task was to find out the possibility of separation from the rocket, with the help of a catapult, with a subsequent descent of the animals by parachute.

Great attention was given to the problem of protection of the animals' lives during the descent trajectory of the rocket when the flight was not fully stabilized. To protect the animals from high-altitude effects, special high altitude suits were used. Experiments on catapulting animals were carried out along two lines:

The catapulting apparatus was started at the height of 85-75 km. (53-47 miles) with the parachute opening immediately. In this case the animals' descent took more than an hour.

The catapulting of the animals from the rocket was effected at 46-39 km. (151-000-128,000 feet); the parachute opened only at the height of 4 km. (13,000 feet).

Experiments have shown that catapulting animals, with their subsequent descent by parachute, is not detrimental to their health or lives.

The third stage of the experiments was started in 1958. The launching of animals into space with the help of rockets was effected at the height of 473 km. (294 miles). They proved that animals came back from these high altitude flights in good health.

All these facts show that the Soviet scientists have carried out a large number of biological experiments in the upper air layers over the past ten years. A direct study of various effects upon living organisms is possible now while it was not possible on the earth. However, only the *Sputnik* could make a biological experiment possible because it meets all the conditions of space flight. In the first place, it concerns the study of the effect of zero gravity, primary cosmic radiation, and certain aspects of solar radiation.

Of particular interest is the state and behavior of the animal at the most crucial points of space flight: the launching of the *Sputnik* and placing it in the orbit. At the moment when it was placed in the orbit the animal was placed in such a manner that the animal sustained a transverse acceleration. We succeeded in registering the condition and behavior of the animal at the moment when the *Sputnik* was placed in the orbit. Immediately after onset the frequency of heart contractions increased by three times compared to the initial frequency. The analysis of the electrocardiogram showed no serious changes in the work of this organ and later, in spite of the growing effect of acceleration, the frequency of the heart contractions decreased.

At the moment when the *Sputnik* was placed in orbit the respiratory rate was from three to four times higher than the initial rate.

There is every reason to believe that the changes noticed in the physiological functions of the animal were

brought about by the sudden effect upon the latter of external irritants: acceleration, noise and vibration which appeared at the start and continued when the rocket was placed in orbit.

From *USSR Magazine*

Laika in the capsule of Sputnik II, which was launched on November 3, 1957.

A careful comparison and analysis of the data received, with the results of the previous laboratory experiments, allows us to reach the conclusion that the animal's condition was satisfactory from the very start, including the moment when the *Sputnik* was placed in orbit. When the *Sputnik* was being placed in orbit a state of zero-gravity set in. Owing to a contraction of the muscles of the limbs, the animal made small bounds on the floor. To judge from the recordings, these movements were smooth and of short duration.

After a very short period, the frequency of heart contractions kept falling, almost reaching the initial stage. However, the space of time during which the number of heart contractions reached its initial state proved to be three times as long as that of the laboratory experiments where the animal was subjected to the effect of the same acceleration that takes place at the moment when the *Sputnik* is placed in orbit. This, in all probability, is due to the fact that after acceleration ceased to have an effect upon the animal in the conditions of terrestrial experiments, the animal found itself in normal conditions; whereas in the *Sputnik*, acceleration was followed by a complete absence of gravity.

The absence of signals from the receptive organ as to the position of the body in space caused a change in the functional state of the nervous system which regulates the blood circulation and breathing, and led to a delay in the return to normal of these functions when the effect of acceleration had already eased. The above mentioned phenomenon may have been aggravated by the accompanying factors

such as vibration and noise, their intensity being more powerful than during the laboratory experiments. Incidentally, the changes in physiological functions of the animal recorded at the beginning of the movement of the *Sputnik* on its orbit coincide on the whole with the results of the previous experiments of high-altitude rockets.

The analysis of the ECG in the zero-gravity * state showed some changes in the configuration of its elements and the duration of its intervals. The changes were in no way pathological and were brought about by the increased functional load at the moment preceding zero-gravity state. The ECG showed alterations of the reflex and nervous character in the work of the heart; at a later stage the ECG showed more and more likeness to the ECG which characterized the initial condition of the animal.

In spite of the absence of gravity, the motor movements of the animal were moderate. The return to normal of the blood circulation and breathing during the zero-gravity state, when the *Sputnik* is in orbit, seems to prove that this factor caused no considerable changes nor any stable changes in the physiological functions of the animal. In other words, the animal got on satisfactorily both during the period when the *Sputnik* was placed in orbit and in its movement on the orbit.

It was impossible to arrive at a final conclusion on the effect of cosmic radiations on the animal, since no direct indication of its physiological influence was discovered. The positive results of these experiments are encouraging for future research geared to protect the life and health of man in space flights.

DISCUSSION

The questions asked of Dr. Kousnetzov immediately following his presentation were answered later in the day:

Colonel John P. Stapp, USAF (MC).—Was there any attempt to catapult and parachute Laika from the *Sputnik?*

Dr. Kousnetzov.—Concerning the catpulting of the Laika, I must answer "no" as such a thing was not programmed.

Dr. Stapp.—Have you done any manned rocket experiments, similar to the dog experiments which you have reported, with an ascent to space altitude and return by parachute?

Dr. Kousnetzov.—Second, in answer to the question of experiments with human subjects in meteorological rockets, as far as it is known there were no such experiments.

Dr. Stapp.—Have you done any balloon experiments with men or animals such as we have reported by Colonel Simons?

Dr. Kousnetzov.—I personally do not have information of any such experiments similar to the Man High project.

Dr. Heinz von Diringshofen.—We want to ask whether from the first moment of the beginning of flight without gravity there was observed on the electrocardiogram a tendency of vagal pulse?

Dr. Kousnetzov.—The transition from the period of acceleration to the period of zero gravity was characterized by immobilization of the . . . function. There were no signs of the vagus pulse.

Captain Neville P. Clarke, USAF (VC).—What cabin pressure was maintained during the dog's life in *Sputnik II* and what was the gas composition?

Dr. Kousnetzov.—In the present (apparatus) there was a system for the regeneration of the oxygen in the atmosphere which maintained the composition of the gas near the terrestrial one.

Dr. Clarke.—What information regarding psychomotor performance has been gained from this experiment?

Dr. Kousnetzov.—The motor activity of the animal was registered. In my paper, I have already mentioned that the movements were small and of short duration.

Dr. Clarke.—Was it possible to define the time and cause of death of the animal?

Dr. Kousnetzov.—It was programmed to get information about the animal during seven days. After that the telemetering of the information ceased as the source of the electric energy was exhausted. From signals (received), the regeneration of air was (known to have) stopped and it is necessary to suppose that the animal died from hypoxia or from oxygen want.